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RESEARCH ARTICLE

BEHAVIOURAL PATTERNS AND RESPONSES TO HUMAN DISTURBANCES OF WILD SOMALI OSTRICHES (*Struthiomolybdophanes*) IN SAMBURU, KENYA.

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Abstract

Somali ostrich has suffered a drastic decline in its population and range mainly due to hunting over the years for meat, skin and feathers. Urgent conservation measures should therefore be taken to reverse this trend particularly in their current population stronghold, the Samburu landscape. In this range, the magnitude and consequences of human disturbance on the ostrich has not been established. The aim of this study was therefore to investigate the behavioural patterns and assess the impacts of human disturbance to the bird. Focal animal sampling was used to establish ostrich's behavioural activity budget while the magnitude of human disturbance was assessed by determining and comparing flight initiation distances in the protected and partially protected areas. Somali ostrich spent most of their diurnal time in feeding and moving, and are more sensitive to human disturbance in the protected areas than they are in the partially protected areas. The results of this study imply that the ratite does not differ in behavioural patterns from other extant ostrich species and human disturbance is not posing a significant threat to its survival within Samburu landscape. Further studies are recommended for better understanding of the conservation status of the newly published species.

Introduction:-

The study of animal behaviour should provide key contributions in solving conservation problems Sutherland (1998). The subject is particularly critical when behaviour is studied as a response to human disturbance or change in the environmental conditions (Sutherland, 1998). Changes in behaviour as a consequence of human disturbance impact negatively to survival and propagation of the wild populations. The level of human disturbance has been repeatedly assessed through behavioural studies. For example, the distance at which a bird takes flight from an approaching danger is known as flight initiation distance (FID) (Stankowich and Blumstein, 2005) and has been used to measure the level of disturbance in wild populations. It has been shown that birds that live in habitats that are prone to high level of human disturbance become highly sensitive and consequently have longer FIDs than those found in less disturbed areas (Møller, 2008). Knowledge on magnitude of human disturbance and the likely impacts it has on survival of birds is therefore critical in conservation of the wild populations particularly in areas prone to human disturbances. However, the information is rarely available

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Somali ostrich has recently been published as distinct species (BirdLife International, 2014). The bird is undergoing a drastic decline in population and thus classified as Vulnerable by IUCN. Its conservation demands an urgent understanding of the scope and the severity of the prevailing threats. Human disturbance could be an important threat to survival and propagation of wild populations in Samburu landscape. This is particularly so in community conservancies in northern Kenya where pastoralist coexist with wild animals. The aims of the current study were therefore to document behavioural patterns of Somali ostrich and assess effects of human disturbance to the bird. The documented information can be useful in the evaluation of the suitability of current conservation practices and the adequacy of existing protected areas.

Materials and methods:-

Study area:-

The study area is located in Samburu County in Kenya at about 1°10′N 36°40′E/ 1.167°N 36.667°E. The area is specifically located to the north of Buffalo Springs National Reserve in Samburu East Sub-County (Fig. 1). The study was conducted within Meibei (Ngaroni, Lpus and Barsalinga in Fig. 1) and West Gate (NgutukOngiron) Community Conservancies located around the foothills of Matthew Ranges and with a total area of 1562.5 km^2. For the purposes of comparison, the study was also conducted in the adjacent Samburu National Reserve, a protected area (104 km^2) established in 1948.

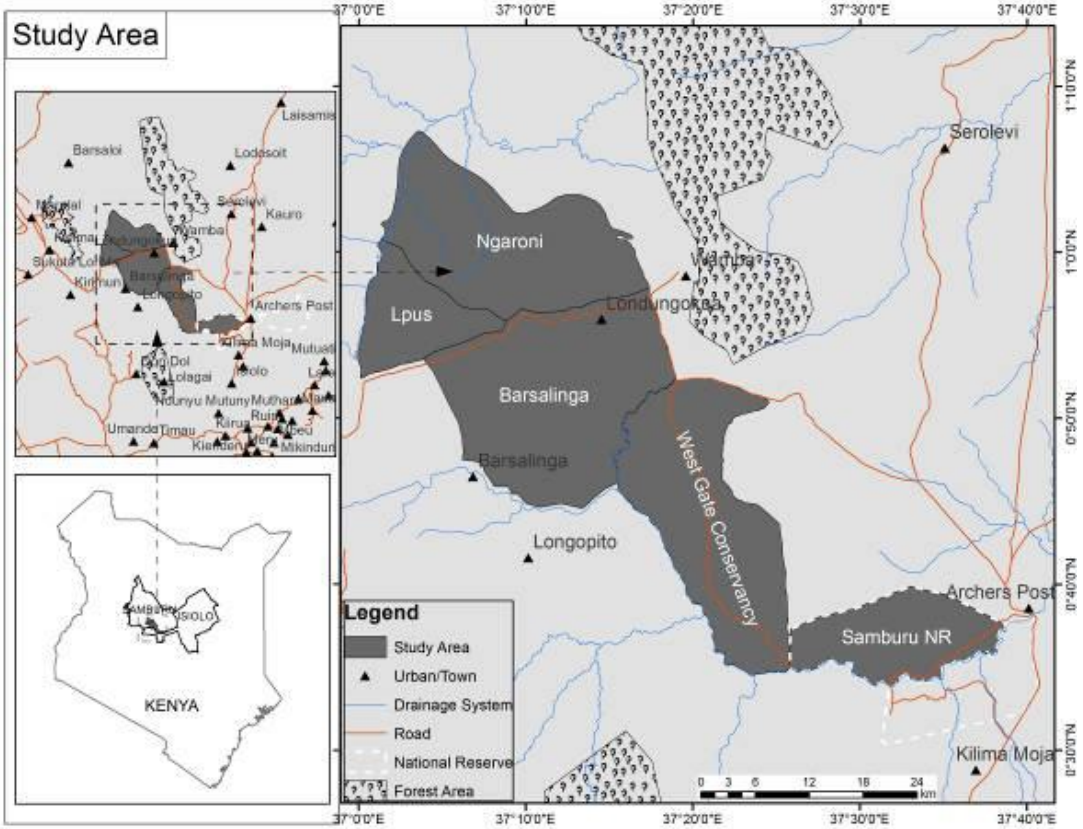

Fig. 1:- A map showing the location of the study area within Samburu CountyMethods.

Seasonal and spatial variation in behaviour of Somali ostrich:-

The behavioural activity budget of the ostrich (solitary or in a group) was investigated at different parts of the study area once every two weeks using focal animal sampling (Altmann, 1974). Data was collected between June, 2014 and May 2015. On each visit, data collection began at 06:00 am and ended at approximately 06:00 pm. The method involved walking (or off road driving or driving along established road network) in search of a Somali ostrich in the study area. Behaviour observation was carried out in the following time blocks; morning (0600 am - 1000 am), midday (01000 am – 0200 pm) and evening (0200pm – 0600 pm). The adult ostrich closest to the observer was observed for 20 minutes and its behaviour recorded using an instantaneous sampling technique (Altmann, 1974). First, the bird's sex and age (adult male; adult female; juveniles; chicks) was recorded. During the 20 minutes of

observation, the activity the ostrich was engaged in was recorded in every minute. The activities that were recorded included: feeding, resting, preening, incubating, aggression, vigilance, walking out of sight, running and courtship display.

Spatial variations in flight initiation distance (FID) in Somali ostrich:-

Flight initiation distance (FID) was determined along roads and tracks within the study area within the same period of study but at different days. Only birds engaged in relaxed behaviours such as feeding, resting or preening were examined. Highly vigilant and nesting individuals were not approached. Immediately after spotting an ostrich or group of ostriches, the vehicle was stopped and group size, group composition, behaviour, habitat, alertness (individuals being alert or not before the approach) and the distance from the car to the centre individual was recorded as the starting distance. The test-person (wearing neutral coloured cloths e.g. green or dark) then approached the ostrich(es) at a steady pace (approx. 0.5 m $sec.^{-1}$). When the birds started moving away, the test-person immediately stopped and the distance to the test-person was recorded. The FID was computed as the difference between the starting distance and the distance to the test-person when the bird(s) took flight.

Data analysis:-

To test whether samples were from a population with normal distribution, Shapiro-Wilk (W) test (Shapiro and Wilk, 1965) was used. Means for samples obtained from a normally distributed populations were compared using parametric tests (student *t*-test and ANOVA) while non parametric tests (Mann-Whitney and Kruskal-Wallis) were performed to compare medians of samples obtained from populations that were not normally distributed.

Results:-

Ostrich behavioural variations:-

In the Samburu landscape, Somali ostriches were found to spend most their time feeding and moving. They were also found to spend substantial proportion of their diurnal-activity time resting and preening, and were rarely engaged in the rest of studied activities (Fig. 2). Generally, ostriches spent the largest proportion of their time feeding during the day. Comparatively, they spent a greater proportion of their 'time-activity budget' feeding during the morning period (63.89%, SD = 6.78) than during midday (59.79%, SD = 5.46) and evening (38.24%, SD = 3.62) periods. Kruskal-Wallis significance test revealed a significant difference in proportions of the time spent in feeding in the three sampling periods of the day (H = 10.58, df = 2, p = 0.004). Mann-Whitney pairwise comparison indicated that significant differences existed between the morning and evening (p = 0.004) and between Midday and evening (p = 0.007) and not between morning and midday.

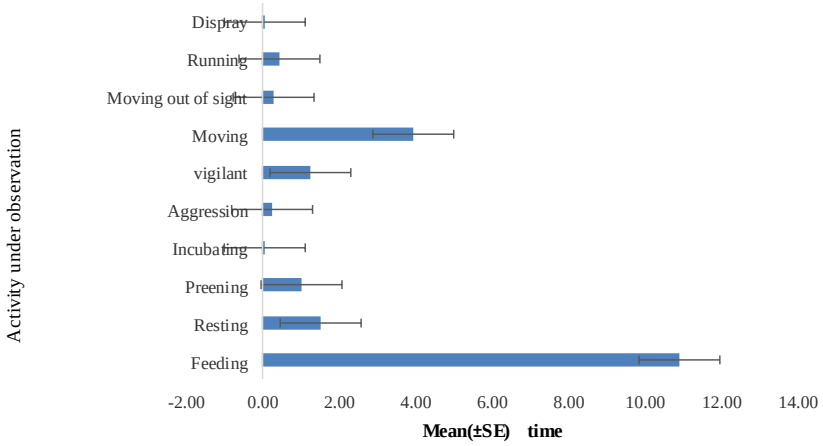

Figure 2:- Mean ±SE time spent by Somali ostrich in each activity studied in Samburu National Reserve, Meibei and West Gate Community Conservancy.

Proportion of time spent in feeding was found to vary between wet and dry seasons. Diurnal activity budget for feeding declined from a mean of 61.22% in dry season to a mean of 44.35% in wet season and difference in mean values was confirmed by student *t*-test to be significant at 95% confidence level (t = 2.2723, p < 0.05). Both males

and females allocated more time to feeding during dry season as compared to the wet season (Male: dry = 59.6%, wet = 40.1; Females: dry =56.6%, wet = 43.3%). However, *t*-test revealed that the difference in time allocated to feeding between the two sexes was not significant (t = -0.118 P = 0.907).

The proportion of time spent in feeding by males (54.3%) was lesser than in females (55.14%). However, the difference in the proportion of the time spend in feeding by the two sexes was not significant (U = 444.5; p = 0.994) based of Mann-Whitney test. Further analysis indicated that the adult males spent a higher proportion (39.8%) of their time feeding at midday than in the morning (34.2%) and evening (25.9%). However, Kruskal-Wallis test revealed that the difference was not significant (H = 7.07, p = 0.287). The proportion of time spent feeding by adult females in the morning and midday were almost similar and higher than the time spent in the evening (Morning = 38.8%., Midday = 38.1% and Evening = 23.1%) and the difference was not significant (H = 3.383; p = 0.183). When percentage of feeding time spent by each of the sex across the three study periods of the day were compared, no significant difference was recorded (χ^2 = 0.31347, df = 2, P < 0.85).

The second most common overall activity of Somali ostrich observed in the study area was movement (19.75%). In contrast to the time allocation pattern for feeding, the proportion of time spent in movement increased with the time of the day (Morning = 9.17%, Midday = 20.63% and evening = 29.14%). The difference in the proportion of time spent on movement at different times of the day was confirmed to be statistically significant based on the one way ANOVA test (F = 4.46, df = 2, p < 0.05). Tukey's pairwise comparison revealed that a significant difference in proportion of time spent in movement existed between Morning and evening (Q = 4.132, p < 0.05) and midday and evening (Q = 3.409, p < 0.05) and not between morning and midday (Q = 0.723, p = 0.866). When time allocated for movement were regressed with time allocated for feeding, a negative linear correlation was obtained (r = -0.45, p < 0.05) implying that movement is significantly correlated with feeding.

Percentage of movement in the "time activity budget" of the Somali ostrich also varied with season and sex (Fig. 3). Generally, ostriches spent more time walking during the wet season than in dry season. Out of the total time spent in movement, 57.1% was spent in wet season as compared to 42.9% spent in dry season. Nonetheless, the variation and the difference between the percentage time spent in the movement in the two seasons was not statistically significant (F = 1.3346, p = 0.4319; t = 2.27, p = 0.0267). While the mean (±SE) time (minutes per observation) spent in movement by male ostriches were almost the same across the two seasons (dry = 3.95 ±0.67 and wet = 3.69 ±1.10), females spent higher mean time in movement during the wet (6.43 ±1.99) season than in dry season (3.95 ±0.75) although the difference was not significant (t = 2.00, p = 0.057).

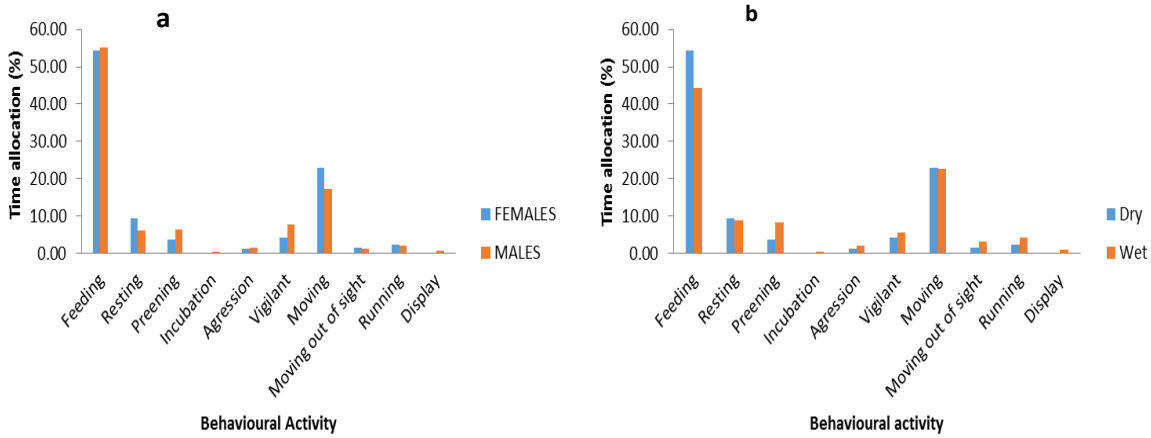

Figure 3:- Comparisons for activity time budget between (a) Somali ostrich males and females, and (b) between wet and dry seasons in Samburu National Reserve, Meibei and West Gate Community Conservancies.

Results of this study revealed that vigilance in Somali ostrich is not significantly influenced by season, sex and time of the day. Although Somali ostriches were found to be more vigilant in wet than they were in dry season with the proportion of time of their diurnal activity budget allocated for vigilance in wet season being 5.7% as compared to 4.26 % allocated in dry season, the difference in means of time spent in a vigilant state in the two seasons was not

significant (t = 0.42937, p = 0.669). Similarly, the difference in means of the time spent in vigilance between males (1.55±0.31 min.) and females (0.85±0.25 min.) was not significant (t = -1.687, p = 0.91). Males spent relatively greater percentage of the time (7.73%) in a vigilant state than females (4.26%). Again, the percentages of time allocated for vigilance varied with period of the day with midday recording highest proportion of time allocated for vigilance (Fig.4) but variation between the means of time spent in vigilance between morning (0.89±0.43), midday (1.52±0.34 min.) and evening (1.18± 0.30 min.) was not significant (F = 0.814, df = 2; p = 0.04478).

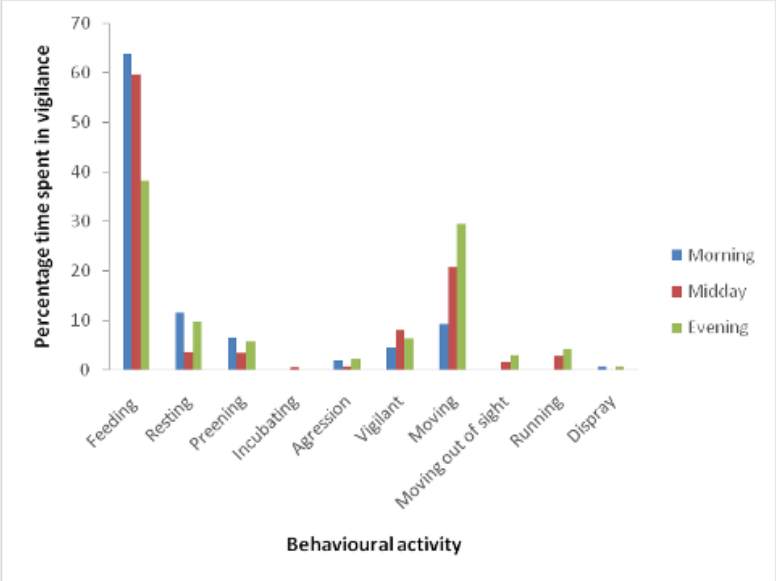

Fig. 4:- Variations in activity time budget for Somali ostrich in the morning, midday and evening in Samburu landscape.

Activities related to breeding (courtship display, aggression and incubation) were rarely observed (Fig. 2). The pattern of preening and resting was more-or-less similar in the reserve and the community conservancies. Based on seasonality, both had a higher time allocation in wet season than dry season. However, males spent more time resting and preening than females (Fig. 3a)

Flight initiation distance (FID):-

A total of 131 walking approachestowards ostriches (solitary or in groups) were conducted. The overall mean (±SE) flight distance for the ostriches in both Samburu National Reserve and community conservancies was 48.6 ±2.09m. In wet season, a mean FID of 46.4 ±2.42m was recorded which was lower than the one recorded for dry season (51.9 ± 3.71m). Nonetheless, the difference was not significant (t = -1.309. p = 0.193). Conversely, the ostriches took flight in the reserve at a significantly higher mean distance of 72 ±6.59m as compared to community conservancies (43±1.00 m) (t = -3.8921, p<0.05). Comparing the two sexes, males were found to be more wary than females (FID male = 50.6±2.81 m; FID females = 46.4± 3.10 m). However, the difference was not significant (t = -1.209, p = 0.229). A strong and significant correlation was shown between the starting distance and the FID (r = 0.82256, p < 0.01) implying that distance at which ostriches take flight from an approaching predator is determined by the distance at which the predator is first detected.

Discussion:-

The time-activity budget for Somali ostrich showed spatial- temporal variability in behaviour as recorded in previous studies on the other extant species of ostrich (McKeegan and Deeming, 1997; Ross and Deeming, 1998; Ahmed et al., 2012). The diurnal activity time budget for Somali ostrich dominated by feeding and movement is consistent with the findings by Sauer and Sauer (1966) that South African ostriches in their natural environment spent most of their time walking and feeding. Devoting most time in feeding by Somali ostrich is broadly in line with a conclusion made by Grier and Burk (1992) that feeding is a critical activity for all organisms in which most time is devoted to. For example, Rubenstein et al. (2004) found that both Grevy's and plain zebras in LewaDownConservany in Laikipia, Kenya spent most of their time feeding during the day.

In the current study, the time spent in feeding varied with period of the day. Proportions of time devoted for feeding were greatest in the morning and least in the evening. These results are supported by previous studies that recorded higher intake of feeds in the early hours of the day by ostriches (Sambraus, 1994; Ahmed, 2012). Moreover, ostriches remain inactive at night (Degen et al.; 1989) and therefore they are expected to feed more in the morning to compensate for the lost feeding time. Additionally, morning period coincides with suitable environmental temperatures and least disturbance from people and livestock in community lands. Nevertheless, the findings of the present study suggesting that ostriches spent the least proportion of their time feeding in the evening contrasts with a report on behavioural traits of red neck ostrich under captive conditions by Ahmed (2012). Under captive conditions, red neck ostriches were found to feed least at the midday and this was attributed to avoidance of calorific enhancement resulting from digestion. In the wild, ostriches in effort to avoid nocturnally active predators, may trade off some feeding time with movements to safer places particularly in protected areas where density of large predators are expected to be high hence devoting less time to feeding in the evening.

The results further indicated that the proportion of time allocated for feeding varied with season but not with sex. The rate of food intake in dry season is expected to be lower than in wet season due to scarcity of food items in the former. Consequently, birds spend more time feeding during the dry season in order to meet their daily caloric requirements. Additionally, the reduced movements in search for food items expected in times of food abundance decreases feeding time required in meeting the ostriches' energy requirements. A lack of variation in time spent in feeding between Somali ostrich males and females documented by the current study is consistent to results obtained by previous studies. For example, William et al. (1993) and Bertram (2014) documented that proportion of day spent in feeding by *S.c.australis*in the wild did not vary between males and females implying that the feeding time allocation by Somali ostrich, like in other ostriches, is not influenced by sex. A study of Great Rhea (*Rhea Americana*) by Reboreda and Fernandez (1997) obtained similar results in which time allocation to feeding bouts varied with vigilance but not with sex.

The results of this study reveal that movement of Somali ostrich to a larger extent is associated with feeding. The time allocated to movement has a strong negative linear correlation with time allocated for feeding implying that there is trade-off between movements and feeding. The cost of increasing time allocated to movement is reducing time for feeding. Animals move for a number of reasons including: search for food, a mate, suitable habitat and escape from predators. However, the key reason why animals move around within the habitat has largely been associated with search for food (Kalamees-Pani, 2010). According to Levy's flight foraging theory, the scale-free foraging involves short movements bouts interspersed with random occasional long movements. Particularly, in resource-poor habitats in which food is scarce or patches are randomly scattered and unpredictable, stochastic and occasional long scale movements have been identified as the most efficient resource search strategy (Cole et al., 2005). Moreover, the ostrich is known to be a gross feeder. For example, it has been shown that adult ostrich on pasture eats three times as much dry matter daily as a cow when expressed as a percentage of body weight (Aganga et al., 2003). Therefore, ostrich movements in Samburu landscape can mainly be associated with search for food required in large quantities. It is expected that after food items are found, the movements is reduced to allow feeding and hence explain the inverse relationship between feeding and movements.

It was expected that during wet season, when food resources are plentiful, the time allocated to movements would decline in favour of other behavioural activities. On contrary, the results of this study showed no significant difference in time allocation to movements between dry and wet season. This can largely be attributed to patchiness of Samburu landscape following habitat degradation and fragmentation reported by Williams (2002) and Letoiye (2014). Ostrich should therefore, in accordance to optimal foraging theory (MacArthur and Painka, 1966), maximize it "currency" (food per unit time) by moving to and foraging in food rich patches within the habitat. Findings of a study on the behaviour of wild ostriches (*S. camelus*) in Mokolodi Nature Reserve, Botswana, by Mush et al. (2008) that males spent more time walking than females was attributed to breeding behaviour such as incubation that limited movement of the female ostrich. In contrast, no significant difference was found in time spent in movements between males and females in the current study suggesting that sex limited behavioural activities do not influence movement of *S. molybdophanes* within Samburu ecosystems significantly.

Generally, all studied activities related to movement; moving, moving out of sight and running were more pronounced in the evening than any other period of the day implying that at this period of the day, ostriches are retreating back to their sleeping sites.

Vigilance is commonly thought as a response to threat of predation and has been found to increase with predation risk (Edmunds, 1974). However, in Samburu, particularly in community lands, vigilance can also be attributed to disturbances associated with human activities. Results indicate that ostriches spent more time being vigilant at midday than in the morning and evening. It is expected that at midday most pastoralist are out in the fields with their livestock herding and consequently causing disturbance to foraging wild animals. This argument is further confirmed by the pattern shown by comfort behavioural activities (resting and preening). Ostriches spent least time on the two activities at midday (Fig. 4) indicating that disturbance is common at this period of the day. Activities relating to breeding were rarely observed suggesting that the Samburu Somali ostrich population could be a sink population with a characteristic low rate of reproduction.

Flight initiation distance:-

Starting distance had the greatest influence on flight initiation distance in Somali ostriches. Distance at which ostriches took flight increased with starting distance implying that the Somali ostriches assess the risk of attack dynamically. Masai ostrich were also found to have a similar pattern of behavioural response to risk of predation or disturbance (Magige et al., 2012) and confirms previous studies by Ydenberg and Dill (1986) and Blumstein (2003). It is argued that the response is probably stronger in large flightless birds that rely on running to escape from eminent predators than in birds that can fly (Fernández-Juricic et al. 2006).

Contrary to the expectation, ostriches in Samburu National Reserve were warier than in community conservancies. This suggests that human disturbance does not a have negative impact on Somali ostriches. Samburu people guided by their cultural beliefs on wildlife existence are known to coexist with wild animals harmoniously (Ocholla et al., 2013). Illegal hunting and persecution of wild animals are not known to exist among them. Lack of serious and continuous threats from people and their livestock may have contributed to reduced wariness among populations in the community lands. A relatively high wariness in the reserve can be attributed to high densities of large predators.

Conclusion and recommendation:-

Generally, Somali ostrich spend most of its time during the day feeding and moving. Human disturbance is not an important threat to survival of ostrich in Samburu. Future studies should seek to address the impact of climate change on the birds. For example, information is required on how climate change impacts on behavioural patterns of the ostriches within their range.

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